**Addition Reactions**

* Atoms are added across a double or triple bond

*Hydrogenation:* H2(g) is added







*Halogenation:* X2(g) is added



**Markovnikov’s Rule:** When H-X or H-OH is added, the H bonds to the carbon that already has the most H’s on it. In other words “*the rich get richer”*

*Hydrohalogenation:* HX is added



*Hydration:* H2O is added



**Substitution Reactions**

## Hydrogen atom is replaced by another atom or group of atoms

*Halogenation:* Halogen replaces a hydrogen when X2(g) or HX is added





*Nitration:* NO2 replaces a hydrogen when HNO3 is added



*Alkylation:* An alkyl group replaces a hydrogen when RX is added









**Elimination Reactions**

* Results in loss of small molecule from larger molecule which causes a single bond to become a double bond, and double to become a triple
* When molecule is not symmetric, isomers occur. The major product is the one where the hydrogen is removed from the carbon with the most carbon-carbon bonds

*Dehydration:*  Water is formed as a product





**Condensation Reactions**

* Two molecules combine for form a larger product, eliminating a small molecule such as water or alcohol

*Dehydration:*  Water is formed as a product, removing an –OH group from one molecule and an H from the other molecule where the 2 molecules are joined





*Esterification:* Reaction of a carboxylic acid with an alcohol to form an ester and water



**Controlled Oxidation Reactions**

* Gain of oxygen or loss of hydrogen
* (O) tells us that the oxygen is supplied by an oxidizing agent K2Cr2O7 or KMnO4 in the presence of H2SO4



Note that the aldehyde can also be oxidized further into a carboxylic acid



Note that the ketone can not be oxidized since there is no H on the C to make room for a double bond.



**Hydrolysis**

* Water molecules are split into H+ and OH- and are used to break down a molecule into smaller molecules
* Sometimes an acid or base can be used instead of water (in cation and anion form)
  + When this is done with esters, the sodium salt of the acid that results is soap
  + This process is called *saponification*





**Reduction**

* Reaction in which carbon atom forms fewer bonds to oxygen atoms or more
* [H] indicates a reducing agent, usually LiAlH­4 or H2 with a Pt catalyst





**Combustion**

* Among most common oxidation-reduction reactions

*Complete Combustion:* Excess of oxygen allows reactants to completely react

Hydrocarbon + O2(g) 🡪 CO2(g) + H­2O(g) + energy

*Incomplete Combustion:* Occurs when insufficient oxygen is present

Hydrocarbon + O2(g) 🡪 C(s) + CO(g) + CO2(g) + H­2O(g) + energy